Magnetic & PA-GISANS

(1) Reduction:

- Data reduction @ ESS
- Magnetic & PA-SANS requests to cansas

(2) Instrument preperation:

- Always including McStas simulations of neutron spin transport?
- Which magnetic test samples?

(3) Analysis:

- Inlcuding micromagnetic simulations from beginning?
- Pitfalls: beam depolarization through sample
- What is the status on magnetic models in DWBA?

(1.1) Data reduction @ ESS

The method to reduce polarised data is based on transmission matrices.

$$\begin{pmatrix} I_{++} \\ I_{+-} \\ I_{-+} \\ I_{--} \end{pmatrix} = \begin{pmatrix} T_{A+} & T_{A-} & \cdot & \cdot \\ T_{A-} & T_{A+} & \cdot & \cdot \\ \cdot & \cdot & T_{A+} & T_{A-} \\ \cdot & \cdot & T_{A-} & T_{A+} \end{pmatrix} \begin{pmatrix} 1 & 0 & \cdot & \cdot \\ 1-T_{F2} & T_{F2} & \cdot & \cdot \\ \cdot & \cdot & 1 & 0 \\ \cdot & \cdot & 1-T_{F2} & T_{F2} \end{pmatrix} \begin{pmatrix} 1 & 0 & \cdot & \cdot \\ 0 & 1 & \cdot & \cdot \\ 1-T_{F1} & 0 & T_{F1} & 0 \\ 0 & 1-T_{F1} & 0 & T_{F1} \end{pmatrix} \begin{pmatrix} T_{P+} & \cdot & T_{P-} & \cdot \\ \cdot & T_{P+} & \cdot & T_{P-} \\ T_{P-} & \cdot & T_{P+} & \cdot \\ \cdot & T_{P-} & \cdot & T_{P+} \end{pmatrix} \begin{pmatrix} S_{++} \\ S_{+-} \\ S_{-+} \\ S_{--} \end{pmatrix}$$

Before reduction

Analyser

Flipper after sample (Off transmits spin+)

Flipper before sample (Off transmits spin+)

Polariser

After reduction

Slide provided by Hal Lee. Reference: Andrew Wildes, Review of Scientific Instruments 70(11):4241 - 4245 · December 1999.

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Before reduction — After reduction

Which beamline components?
- Supermirrors
- ^{3}He-cells
- Flippers

Which polarization option?
- Half-polarized
- Full-polarized

Which DB characterization?
- Incoming **unpolarized** beam
- Incoming **polarized** beam

In-situ & single channel correction possible:

$$\begin{pmatrix} I^{++} \\ I^{+-} \\ I^{-+} \\ I^{--} \end{pmatrix}(t,\lambda) \Rightarrow \frac{1}{N}\sum_{N} PA\left(\frac{I(t,\lambda)}{Beaml.-corrections}\right) \Rightarrow \begin{pmatrix} S^{++} \\ S^{+-} \\ S^{-+} \\ S^{--} \end{pmatrix}(t,\lambda)$$

scipp

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The method to reduc

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Before reduction

Analys

Polariser

After reduction

Idea:

- **PA-correction "on-the-fly"**
- **Con: Maybe not very precise?**
- **Pro: Good for direct decision making!**
- **Opinions?**

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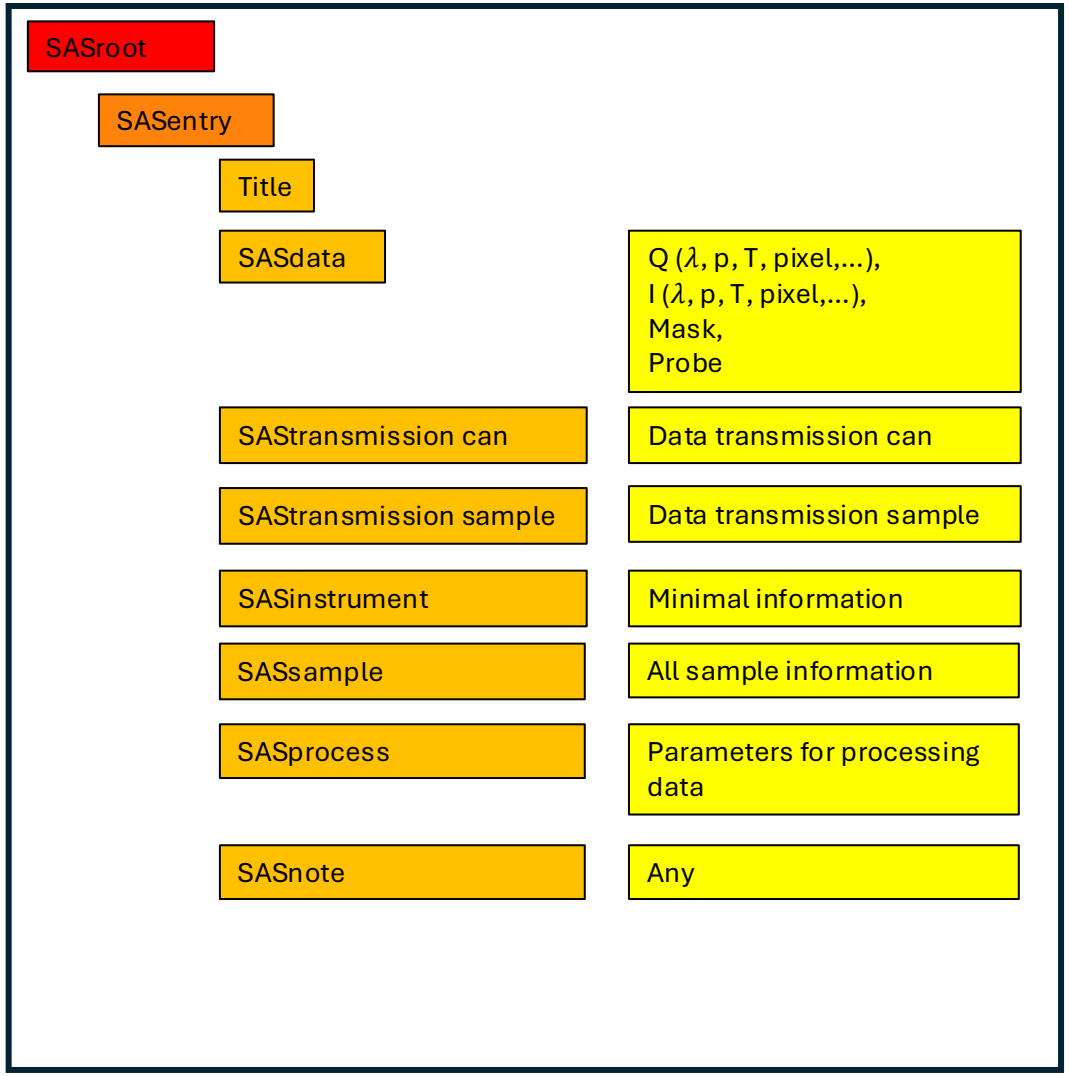
(1.2) Magnetic & PA-SANS requests to cansas

Currently



Proposition to cansas for PA-SANS (Formal request coming):
https://wiki.cansas.org/index.php?title=NXcanSAS_v1.1
(Lucas Wilkins, Dirk Honecker, Stephen King, Andrew Jackson, Annika Stellhorn)

(1.2) Magnetic & PA-SANS requests to cansas

Currently

SASroot	
SASentry	
Title	
SASdata	Q (λ, p, T, pixel,...), I (λ, p, T, pixel,...), Mask, Probe
SAStransmission can	Data transmission can
SAStransmission sample	Data transmission sample
SASinstrument	Minimal information
SASsample	All sample information
SASprocess	Parameters for processing data
SASnote	Any

What will be changed

SASroot

SASentry

SASdata

Proposal 1-4:

Q (λ, p, T, pixel,...),
I (λ, p, T, pixel,...),
Pin: (-1, 0, 1),
Pout: (-1, 0, 1),
(Pol-SANS: one parameter is fixed to 0)
Mask,
Probe

SASinstrument

Proposal 5-6:

In addition to the current format:
- SASAnalyzer & SASFlipper
(only SASpolarizer so far),
- Transmission_spectrum,
- Efficiency_spectrum,

Proposal 8-10:

New parameters for:
- SAS Flipper
- SAS Analyzer
- SAS Polarizer
- position, direction (cart./spher.)
- name, decay_time, polarization_initial, pressure, length, distance

SASsample

Proposal 7:

Magnetic-/Electric field:
- Direction (cart./spher)
- magnitude

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be changed

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SASsample

Magnetic-/Electric field:
- Direction (cart./spher)
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For Magnetic / PA-GISANS:

- **Take over nxs-format from SANS?**
- **Include ORSO standards?**
- **See also discussion on “data-formats”**

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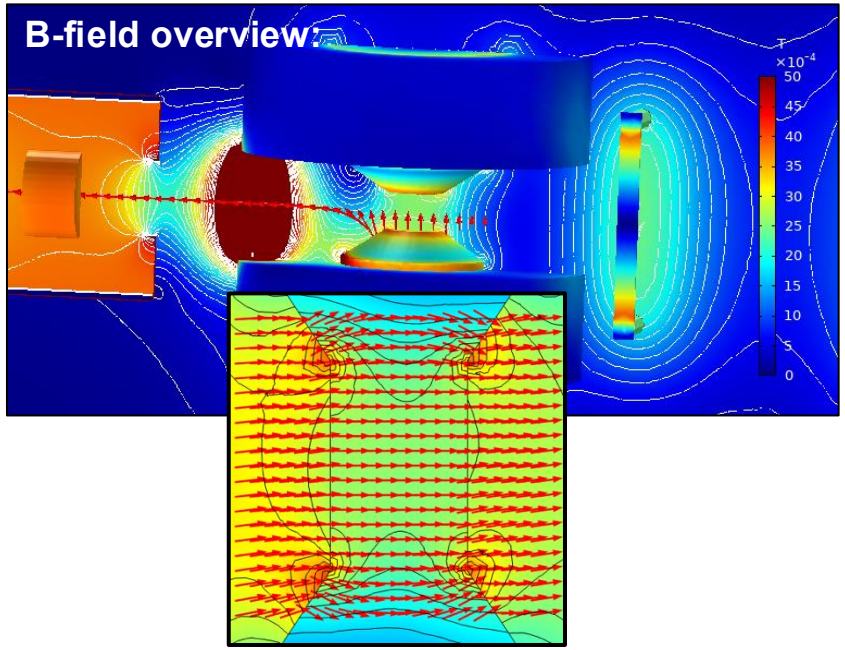
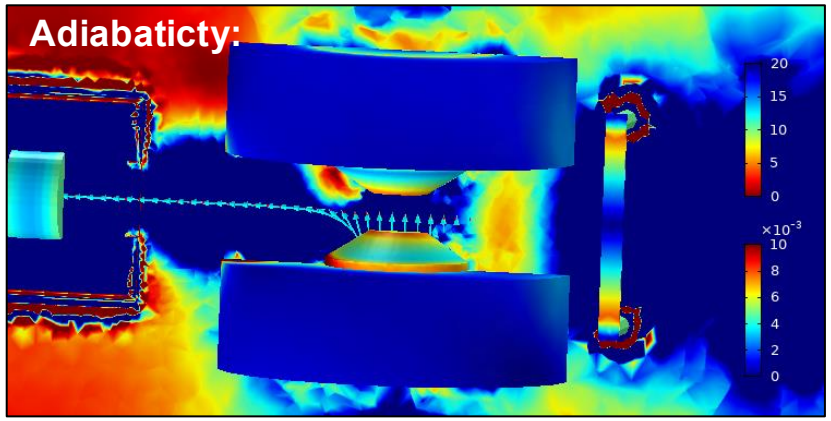
(2.1) Instrument preperation: McStas

Neutron spin-transport considerations:

- 2x spin rotations along trajectory





A. Stellhorn, et al., *Neutron adiabaticity and its impact on data analysis, illustrated for polarized GISANS*, EPJ Web Conf. **286** (2023): 06002.

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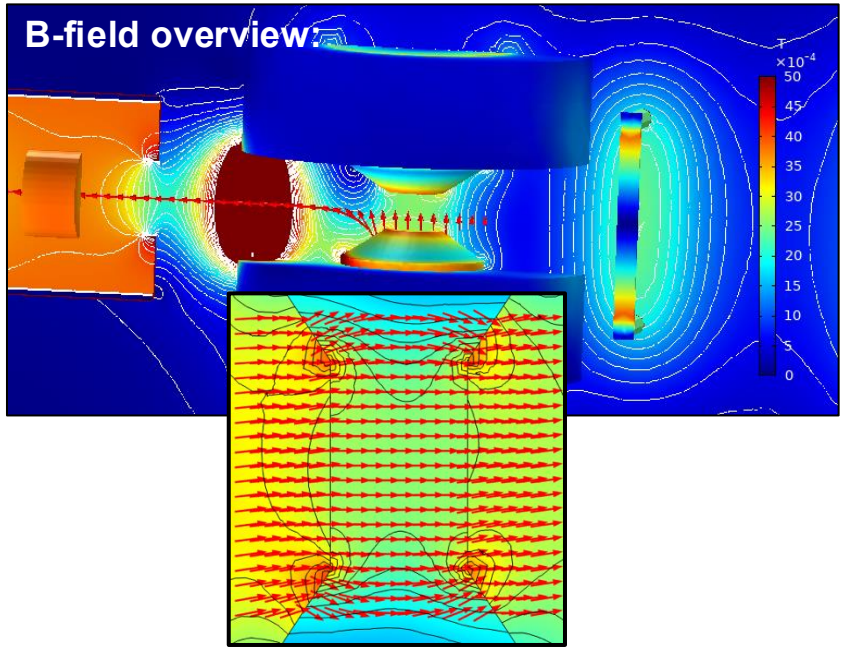

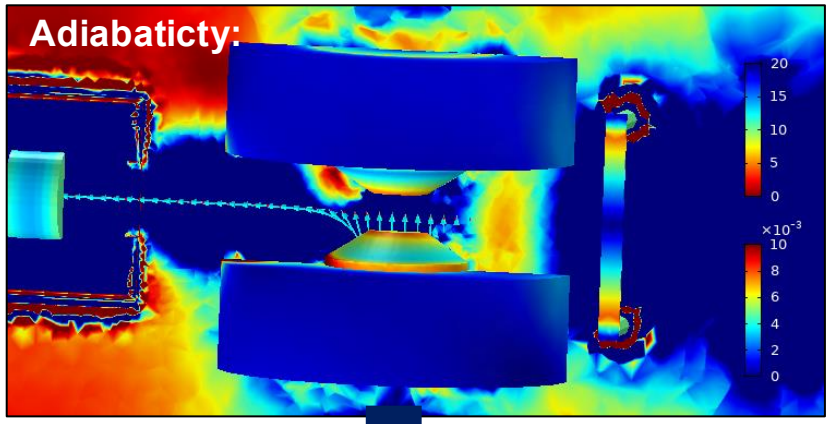

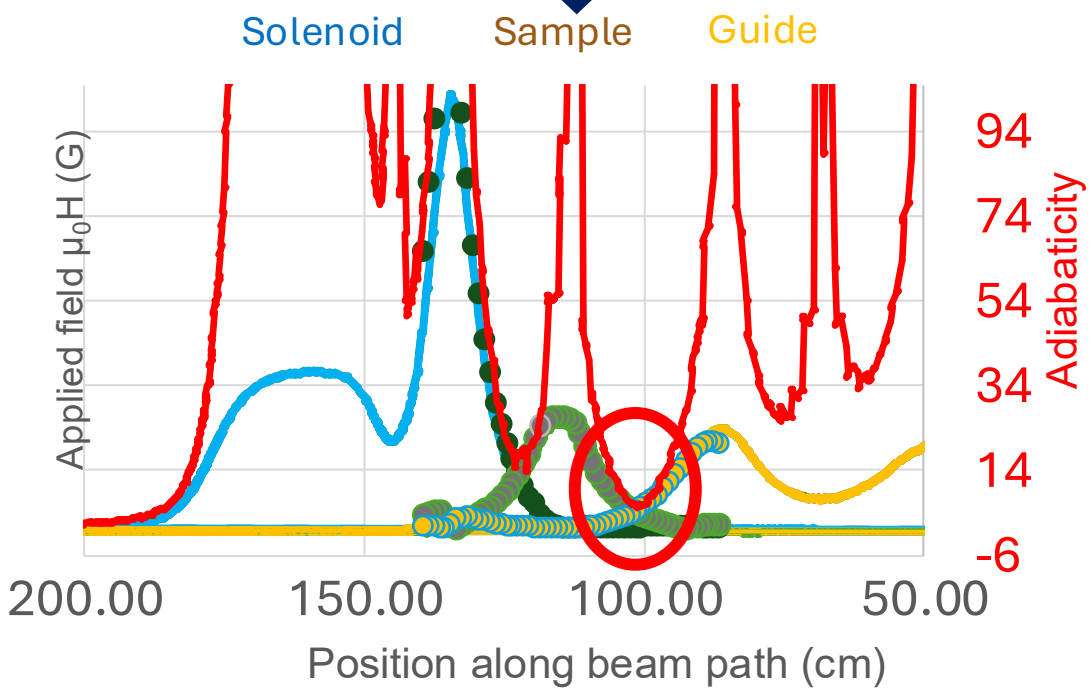

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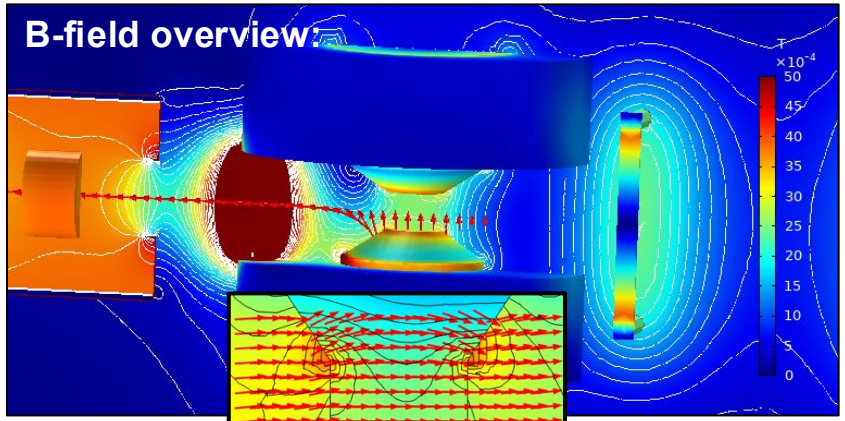
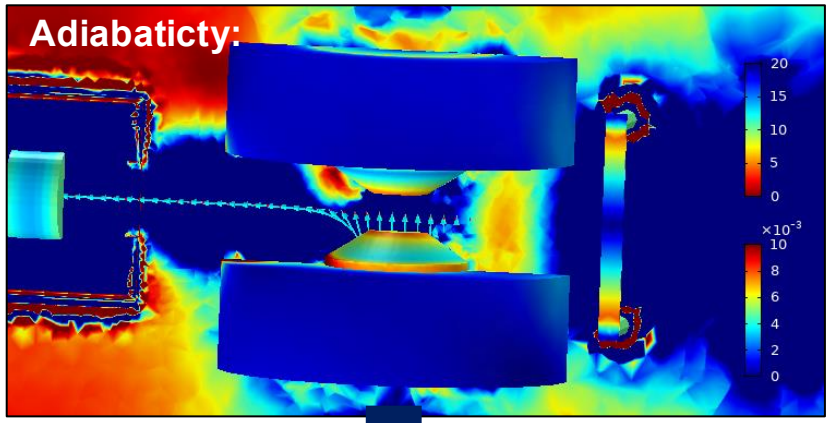
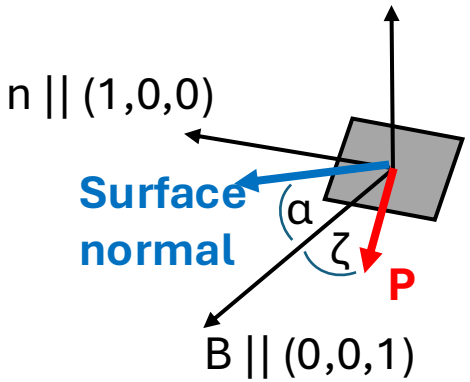
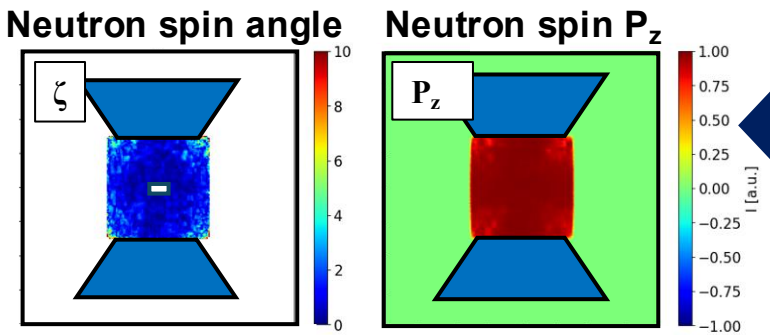
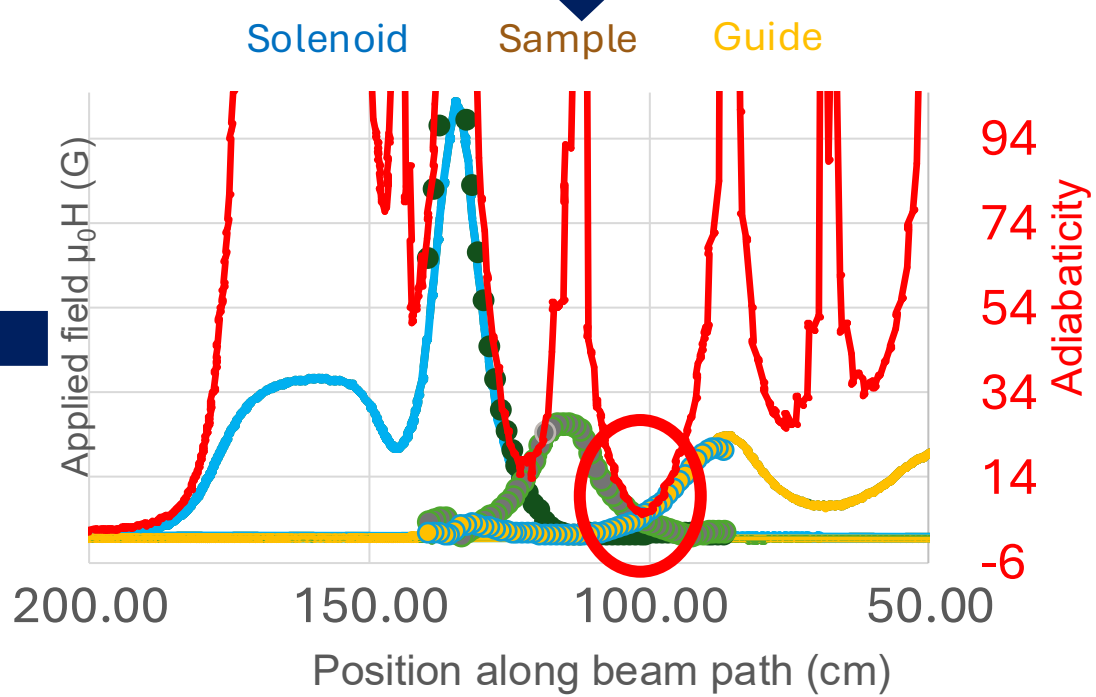
- Spin angle w.r.t Magnet-field: 9°











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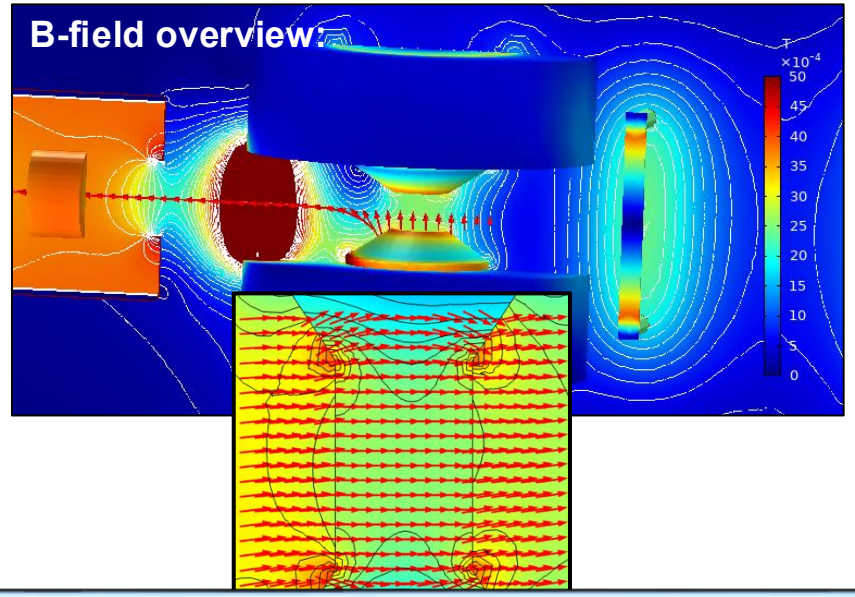
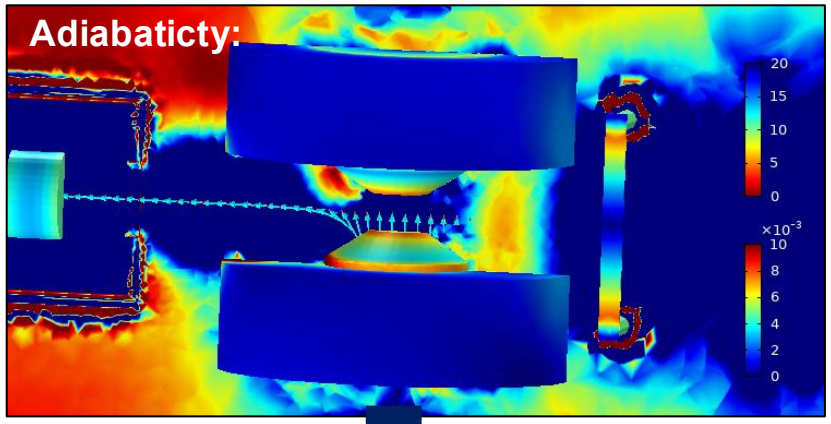
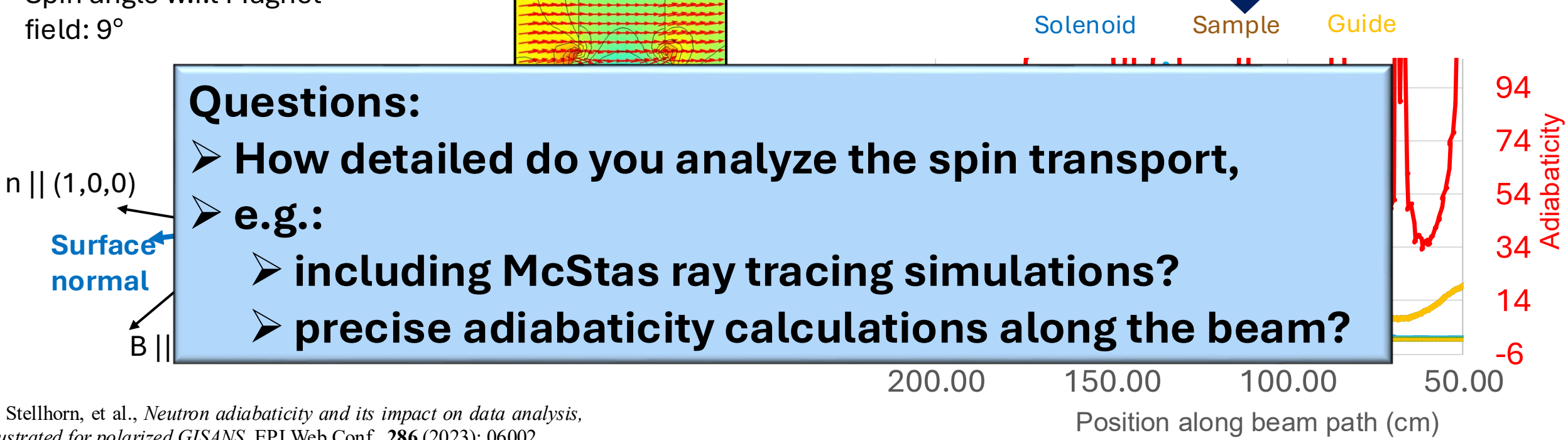






Questions:

- **How detailed do you analyze the spin transport,**
- **e.g.:**
  - **including McStas ray tracing simulations?**
  - **precise adiabaticity calculations along the beam?**

A. Stellhorn, et al., *Neutron adiabaticity and its impact on data analysis, illustrated for polarized GISANS*, EPJ Web Conf. **286** (2023): 06002.

(2.2) Instrument preperation: Magnetic test samples

For non-magnetic calibration:

- Gratings, Nanoparticles, NIST round-robin,...
- Suggestions from S. Jaksch for topic “Normalization”

For Polarization-Analysis corrections:

- Supermirrors: by a badly polarized SM with high-m
- For ^{3}He cells: by glassy carbon (same as above)

Test samples:

Need:

- Formerly well-characterized samples
- Something stable, non-oxidizing!

Ideas:

- Lithographically patterned Permalloy stripes?
- Ferromagnetic domain systems?
- Commercial gratings filled with Permalloy / Ferrite fluid?

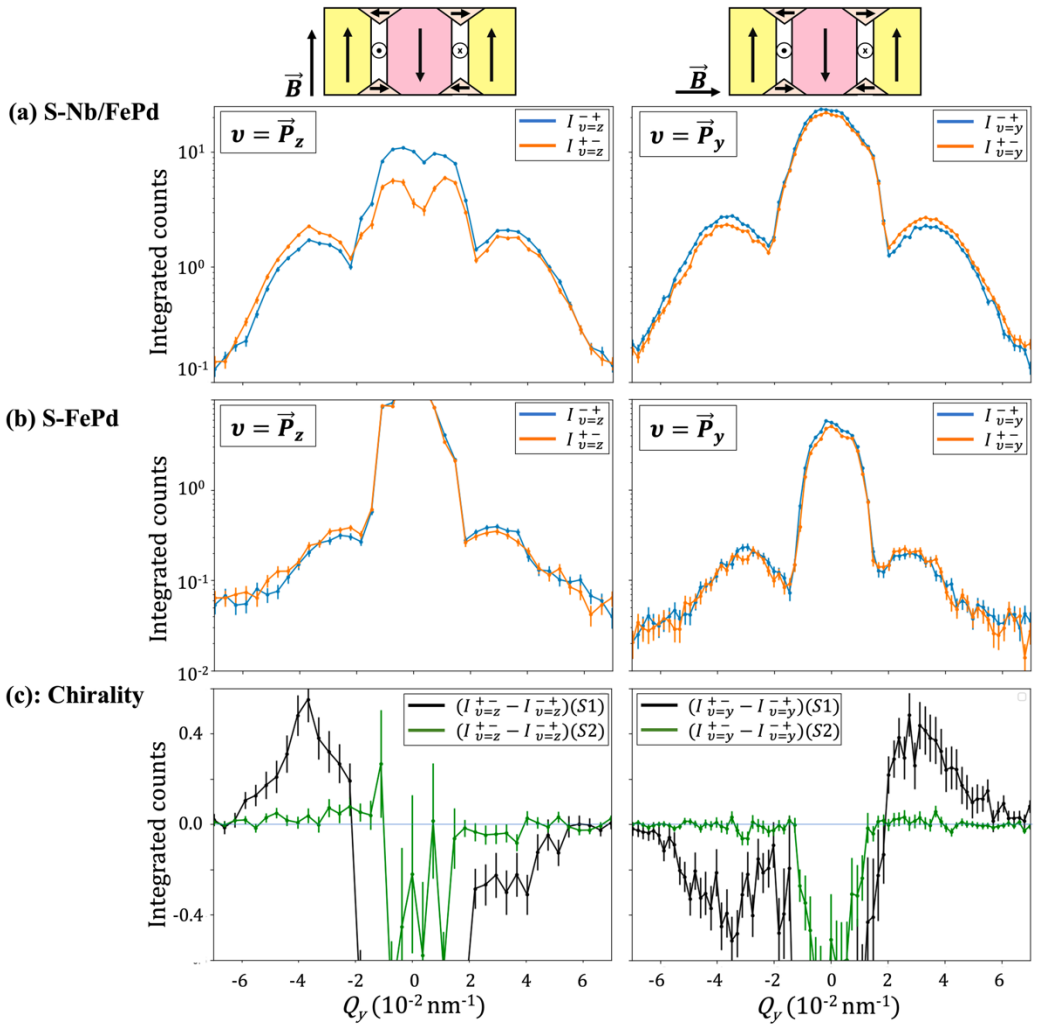
Questions for magnetic test samples:

- **What do you use in your facility?**
- **Is it something standardized?**
- **Survey on non-magnetic + magnetic references?**
- **What is used in PNR? Could then be patterned.**

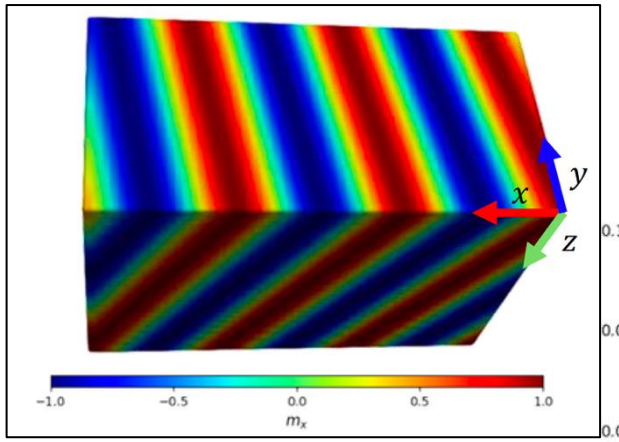
(3) Magnetic & PA-GISANS Analysis

Example: Magnetic chirality in FePd thin films

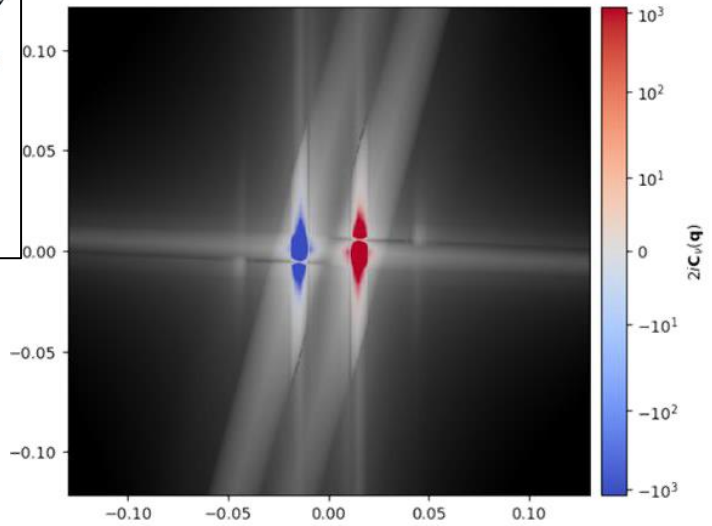
PA-GISANS



DFT/micromag. simulations



$$\Delta I_{\nu}^{SF} = \frac{1}{2}(I^{+-} - I^{-+})_{\nu}$$
$$= 2i(\mathbf{M}_{\perp}^{*} \times \mathbf{M}_{\perp})_{\nu} = 2i\mathbf{C} \cdot \boldsymbol{\nu} = 2iC_{\nu}.$$



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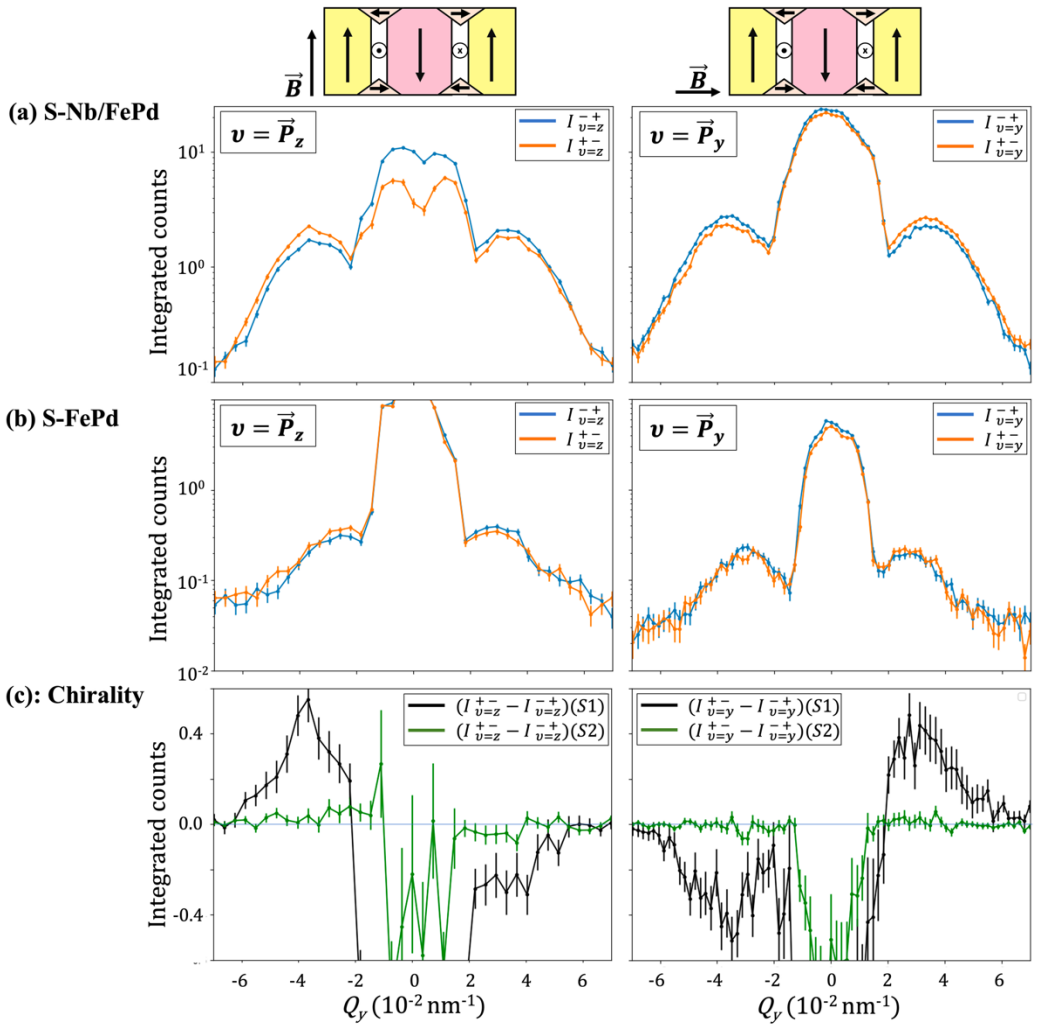

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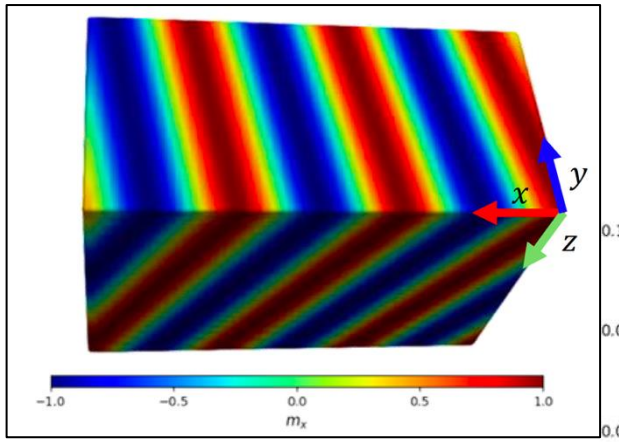

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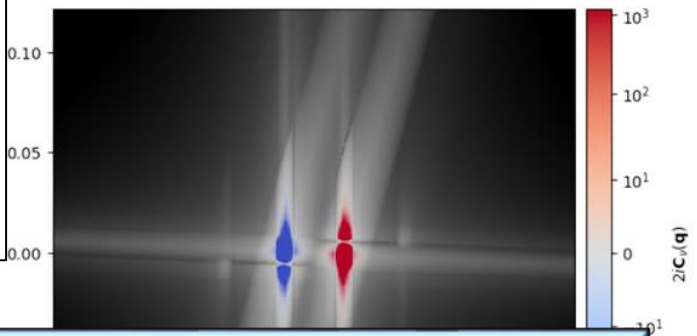

Questions:

- **Make comp. with theoretical models a standard?**
- **Include from beginning in software considerations?**

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